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Indian Standard

**SPECIFICATION FOR
STEEL PIPES FOR HYDRAULIC PURPOSES**

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Indian Standard

SPECIFICATION FOR STEEL PIPES FOR HYDRAULIC PURPOSES

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(Continued on page 2)

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IS : 6631 - 1972

(Continued from page 1)

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 12 October 1972, after the draft finalized by the Steel Tubes, Pipes and Fittings Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Keeping in view the manufacturing and trade practices in the country, this standard has been prepared to meet the increased application of steel pipes for hydraulic purposes.

0.3 In preparing this standard assistance has been derived from BS 778 : 1966 'Specification for steel pipes and joints for hydraulic purposes', issued by the British Standards Institution, London.

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers the requirements of three types of seamless and welded carbon steel pipes for hydraulic purposes employing working fluids such as water and oil in sizes from 13.5 mm to 127 mm outside diameter, suitable for the following design pressures:

- a) Up to and including 9.8 N/mm²,
- b) Above 9.8 N/mm² up to and including 17 N/mm², and
- c) Above 17 N/mm² up to and including 34 N/mm².

SECTION I GENERAL REQUIREMENTS APPLICABLE TO ALL THREE TYPES OF STEEL PIPES

2. TYPES AND GRADES

2.1 Steel pipes for hydraulic purposes shall be of the following types (based on the process of manufacture) and grades (the number indicating

*Rules for rounding off numerical values (revised).

IS : 6631 - 1972

the minimum yield stress in N/mm^2 of the material):

<i>Section</i>	<i>Type</i>	<i>Grade</i>
2	Hot finished seamless (HFS)	205 and 245
3	Cold drawn seamless (CDS)	205 and 245
4	Electric resistance or induction butt welded (ERW)	205 and 245

2.2 Designation — Steel pipes are designated by symbols to indicate the process of manufacture, followed by the minimum yield stress in N/mm^2 . For example, hot finished seamless pipes having a minimum yield stress of 205 N/mm^2 are designated as HFS 205.

3. MATERIAL

3.1 The ladle analysis of steel, when determined in accordance with IS : 228-1959*, shall be as follows:

<i>Constituent</i>	<i>Percent, Max</i>
Sulphur	0.050
Phosphorus	0.050

3.2 Product Analysis — Permissible variation in case of product analysis from the limits specified in 3.1 shall be as follows:

<i>Constituent</i>	<i>Percent, Max</i>
Sulphur	0.005
Phosphorus	0.005

4. SUPPLY OF MATERIAL

4.1 General requirements relating to the supply of steel pipes for hydraulic purposes shall conform to IS : 1387-1967†.

5. HEAT TREATMENT

5.1 CDS and ERW pipes shall be normalized at 880 to 920°C.

6. WORKMANSHIP

6.1 All pipes shall be free from harmful defects and shall be reasonably smooth and free from loose scale and rust. Unless otherwise specified, ends shall be cut square.

*Methods of chemical analysis of pig iron, cast iron and plain carbon and low-alloy steels (*revised*).

†General requirements for the supply of metallurgical materials (*first revision*).

7. MACHINING

7.1 Where pipes are required to be machined, finished dimensions shall be stated in the enquiry and order. It is recommended that the method of machining should also be stated.

8. STRAIGHTNESS

8.1 Unless other tolerances are agreed to between the purchaser and the manufacturer, pipes shall not deviate from straightness by more than 1/600th of any length, measured at the centre of that length.

9. LENGTH

9.1 Unless otherwise specified the pipes shall be supplied in random lengths of 4 to 7 metres.

9.2 Where 'exact' or 'cut length' is specified, it shall be within the tolerance of plus 6 mm and minus zero.

10. SURFACE PROTECTION

10.1 Unless otherwise specified, pipes shall be supplied uncoated or with a suitable protective coating at the option of the manufacturer.

10.2 Galvanising shall be done in accordance with and conform to the requirements of IS : 4736-1968*.

11. TESTING

11.1 The manufacturer shall carry out the specified tests applicable to each type of pipe, and he shall, if required by the purchaser, supply a certificate stating that the pipes comply with the specified requirements. When the purchaser desires such certificates, this shall be stated in the enquiry and order.

11.2 When the purchaser requires additional tests related to his order, such tests shall be the subject of agreement between the purchaser and the manufacturer.

12. MECHANICAL TESTS

12.1 Where the purchaser does not require tests specifically related to his order, the manufacturer shall undertake the tests specified in the appropriate section of this standard from a sufficient number of pipes to ensure that the pipes comply with the requirements of that section.

*Specification for hot-dip zinc coatings on steel tubes.

12.2 Where the purchaser requires tests specifically related to his order, the number of pipes on which mechanical tests shall be performed, shall be as follows:

Up to and including 101.6 mm outside diameter	1 pipe in each 400 tubes as made
Over 101.6 mm outside diameter	1 pipe in each 200 pipes as made

12.3 The samples shall be taken at random from lots as presented for inspection, each lot containing not more than 400 pipes for sizes up to and including 101.6 mm outside diameter or not more than 200 pipes for sizes over 101.6 mm outside diameter. If the number of samples specified in this clause, when applied to a particular order necessitates a number of pipes which includes a fraction, the fraction shall be treated as unity.

12.4 The following tests, where applicable, shall be carried out.

12.5 Tensile Test — This should be carried out in accordance with IS : 1894-1962* on one of the following at the manufacturer's option:

- Length cut from the end of the selected pipe (the ends being for grips or flattened where necessary), and
- Longitudinal strip cut from the pipe and tested in the curved condition, or a test piece cut circumferentially, and flattened before testing. For welded pipes, the test piece shall not include the weld.

12.5.1 The tensile strength, the yield stress and the percentage elongation shall be not less than those specified in Table 1.

TABLE 1 TENSILE PROPERTIES

PIPE DESIGNATION	TENSILE STRENGTH N/mm ²	YIELD STRESS N/mm ²	ELONGATION, PERCENT, Min, on $5.65\sqrt{S_0}$
HFS 205 } CDS 205 } ERW 205 }	330	205	932 0/TS
HFS 245 } CDS 245 } ERW 245 }	410	245	932 0/TS

S_0 = Original cross-sectional area.

TS = Tensile strength in N/mm².

9.81 N/mm² = 1 kgf/mm².

*Method for tensile testing of steel tubes (first revision).

12.5.2 The percentage elongation is specified in this standard and shall be reported with reference to a gauge length of $5.65\sqrt{S_0}$, where S_0 is the original cross-sectional area of the test specimen.

12.5.3 The tensile strength shall be the actual value obtained from the test piece.

12.6 Flattening Test — It shall be carried out in accordance with IS : 2328-1963*.

12.6.1 A ring not less than 40 mm in length, cut from the end of the pipe shall withstand, without showing either crack or flaw, being cold flattened between parallel plates until, when the pressure is released, the interior surface of the test piece at the middle, remain apart at a distance not greater than that specified in Table 2. Burrs shall be removed before testing.

TABLE 2 TEST REQUIREMENTS FOR FLATTENING TEST ON PIPES UP TO AND INCLUDING 114.3 mm OUTSIDE DIAMETER

PIPE DESIGNATION	DISTANCE APART OF INTERIOR SURFACE
HFS 205 } CDS 205 } ERW 205 }	4 t or half the inside diameter, whichever is smaller
HFS 245 } CDS 245 } ERW 245 }	6 t or three-quarters the inside diameter, whichever is smaller

t = thickness of the tube.

12.6.2 Welded pipes shall have the weld placed at 90° to the direction of flattening.

12.7 Bend Test (Strip) — A strip not less than 38 mm wide, cut circumferentially from one end of the pipe shall, when cold, be doubled over in the direction of original curvature round a bar of the diameter specified in Table 3, without showing either crack or flaw. Slight premature failures at the edges of a specimen shall not be considered a cause for rejection.

12.7.1 If the test is on the weld, the strip shall be cut so that the weld is near the middle of the strip and the weld shall be placed at the point of maximum bend.

12.8 Bend Test (Whole Pipe) — The test shall be carried out in accordance with IS : 2329-1963†. The pipe shall be bent cold, by means of pipe bending machine round a grooved former. The radius at the

*Method for flattening test on steel tubes.

†Method for bend test on steel tubes.

bottom of the groove shall be (a) six times the outside diameter of the pipe in case of ungalvanized pipe and (b) eight times the outside diameter of the pipe in case of galvanized pipe. The pipe shall not be filled. The weld shall be at 90° to the plane of bending.

12.8.1 The pipe shall show no sign of crack or flaw when bent through 90° in the case of galvanized pipe and through 180° in the case of ungalvanized pipe

12.9 Crushing Test — A piece of pipe approximately equal in length to one and a half times the outside diameter, cut from one end, with the ends parallel and square with its axis, shall be crushed cold lengthwise until its length is reduced by not less than the percentage of the original length specified in the appropriate section. The pipes shall show no sign of crack or flaw as a result of this test.

12.10 Drift Expanding Test — The test shall be carried out in accordance with IS : 2335-1963*. A piece of pipe approximately 100 mm long cut from one end shall be expanded cold, by means of a conical drift having an included angle of 40° to 60° until the internal diameter of the pipe at the mouth has been increased by not less than the percentage specified in the appropriate section. Belling of the pipes by spinning methods is not permissible. The pipe shall show no sign of crack or flaw as a result of this test.

12.11 Hydraulic Test — Every pipe shall be tested at the manufacturer's works to the hydraulic pressure which shall be one and a half times the design pressure given in Table 4. Hydraulic pressure shall be maintained sufficiently long for proof and inspection. Any pipe failing to withstand the hydraulic pressure test required shall be deemed not to comply with this standard.

**TABLE 3 TEST REQUIREMENTS FOR BEND TEST (STRIP)
ON PIPES OVER 114.3 mm OUTSIDE DIAMETER**

(Clause 12.7)

PIPE DESIGNATION	DIAMETER OF BAR TUBES UP TO AND INCLUDING 9.5 mm THICKNESS	DIAMETER OF BAR TUBES OVER 9.5 mm THICKNESS
HFS 205 } CDS 205 } ERW 205 }	3t	4t or two-thirds the inside diameter, whichever is smaller
HFS 245 } CDS 245 } ERW 245 }	4t	5t or seven-tenths the inside diameter, whichever is smaller

t = thickness of the tube.

*Method for drift expanding test on steel tubes.

13. RETESTS

13.1 Should a pipe selected for test fail in any one or more of the tests specified, two further tests of the same kind shall be made from the same or another pipe at the manufacturer's discretion.

13.2 If both the repeat tests are satisfactory the pipes shall be accepted provided that in all respects they comply with the requirements of this standard. If failure occurs in either of the retests, the pipes represented by these test pieces shall be deemed not conforming to this Indian Standard.

13.3 If the pipes represented have been subjected to heat treatment, they may be reheat-treated and tested in accordance with 12.

14. DIMENSION OF PIPES

14.1 The dimensions of the pipes shall be in accordance with Table 4.

TABLE 4 DIMENSIONS OF PIPES

(Clauses 12.11 and 14.1)

All dimensions in millimetres.

OUTSIDE DIAMETER	THICKNESS FOR DESIGN PRESSURE									
	9.8 N/mm ²				17 N/mm ²				34 N/mm ²	
	Steel 205		Steel 245		Steel 205		Steel 245		Steel 245	
	Oil	Water	Oil	Water	Oil	Water	Oil	Water	Oil	Water
	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
13.5	2.9	2.9	—	—	2.9	2.9	—	—	2.9	2.9
17.2	2.9	2.9	—	—	2.9	2.9	—	—	3.2	3.6
21.3	3.2	3.2	—	—	3.2	3.2	—	—	4.0	4.5
26.9	3.2	3.2	—	—	3.6	4.0	3.2	3.2	5.4	5.4
33.7	4.0	4.0	—	—	4.5	5.0	4.0	4.5	6.3	7.1
42.4	4.0	4.0	—	—	5.4	5.9	5.0	5.4	8.0	8.7
48.3	4.0	4.5	—	4.0	6.3	7.1	5.4	5.9	8.7	9.3
60.3	4.8	5.4	4.5	4.8	8.0	8.7	6.3	7.1	11.0	12.5
76.2	5.9	7.1	5.4	5.9	9.5	11.0	8.0	8.7	14.0	16.0
88.9	7.1	8.0	5.4	6.4	11.0	12.5	8.7	9.5	17.5	19.0
101.6	8.0	8.7	6.4	7.1	12.5	14.0	11.0	11.0	19.0	20.6
114.3	8.7	9.5	7.1	8.0	14.0	16.0	11.0	12.5	20.6	24.0
127.0	11.2	12.5	8.7	9.5	17.5	19.0	14.0	16.0	25.4	28.0

15. INFORMATION TO BE SUPPLIED BY THE PURCHASER

15.1 The purchaser shall include the following items in his enquiry or order:

- a) Design pressure;
- b) Type of pipe and grade of steel required;
- c) Outside diameter, thickness (*see* Table 4) and length of the pipe;
- d) Whether pipes are to have plain ends, screwed ends without flanges or screwed ends with flanges screwed on;
- e) Requirements of machining;
- f) If it is desired to witness mechanical or other tests or if test certificates are required;
- g) Details of any additional marking required; and
- h) Details of any protection required.

16. MARKING

16.1 The pipe shall be marked with the following particulars:

- a) Manufacturer's name or trade-mark,
- b) Outside diameter and thickness, and
- c) Grade.

16.1.1 The product may also be marked with Standard Mark.

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufactures or producers may be obtained from the Bureau of Indian Standards.

SECTION 2 HOT FINISHED SEAMLESS STEEL PIPES (HFS)

17. TENSILE PROPERTIES

17.1 The tensile properties of HFS steel pipes when tested in accordance with **12.5** shall conform to the requirements as laid down in Table 1.

18. DIMENSIONS AND DESIGN PROPERTIES

18.1 Dimensions of the pipes most commonly used are given in Table 5.

18.2 Design properties of the pipes are given in Appendix A.

TABLE 5 SIZES OF HOT FINISHED SEAMLESS STEEL PIPES

(Clause 18.1)

All dimensions in millimetres.

OUTSIDE DIAMETER	THICKNESS
42.4	4.0, 5.4, 5.9, 8.0, 8.7
48.3	4.0, 4.5, 5.4, 5.9, 6.3, 7.1, 8.7, 9.5
60.3	4.5, 4.8, 5.4, 6.3, 7.1, 8.0, 8.7, 11.0, 12.5
76.2	5.4, 5.9, 7.1, 8.0, 8.7, 9.5, 11.0, 14.0, 16.0
88.9	5.4, 6.4, 7.1, 8.0, 8.7, 9.5, 11.0, 17.5, 17.5, 19.0
101.6	6.4, 7.1, 8.0, 8.7, 11.0, 12.5, 14.0, 19.0, 20.6
114.3	7.1, 8.0, 8.7, 9.5, 11.0, 12.5, 14.0, 16.0, 20.6, 24.0
127.0	8.7, 9.5, 11.2, 12.5, 14.0, 16.0, 17.5, 19.0, 25.4, 28.0

19. TOLERANCES**19.1** Pipes shall conform to the following tolerances:

	<i>Tolerance</i>
a) Outside Diameter:	
Sizes up to and including 48.3 mm	+ 0.5 mm - 1.0 mm
Sizes over 48.3 mm	± 1 percent
b) Thickness	± 12.5 percent

20. OTHER TESTS

20.1 In addition to the tensile test specified in 12.5 and the hydraulic test specified in 12.11 each selected pipe when tested in accordance with either 12.6 or 12.7 or 12.8 shall satisfy the requirements as laid down in Table 2 or 3 or 12.8.1 as appropriate.

SECTION 3 COLD DRAWN SEAMLESS STEEL PIPES (CDS)**21. TENSILE PROPERTIES**

21.1 The tensile properties of CDS steel pipes when tested in accordance with 12.5 shall conform to the requirements as laid down in Table 1.

22. DIMENSIONS AND DESIGN PROPERTIES

22.1 Outside diameters and thickness of this type of the pipes are not specified in this Indian Standard since it is possible to supply a wide range of sizes. Purchasers should ascertain from the manufacturer the sizes readily available before completing any design work which incorporates this type of pipe.

22.2 Design properties of these pipes are given in Appendix A.

23. TOLERANCES

23.1 The following manufacturing tolerances shall not be exceeded.

23.1.1 Outside Diameter — Where the ratio of outside diameter to thickness is not greater than 33 : 1, the tolerances shall be as laid down in Table 6.

TABLE 6 TOLERANCES

OUTSIDE DIAMETER		TOLERANCE
Over	Up to and Including	
mm	mm	mm
—	25.4	± 0.13
25.4	38.1	± 0.15
38.1	51.0	± 0.18
51.0	63.5	± 0.20
63.5	76.5	± 0.23
76.1	88.9	± 0.25
88.9	101.6	± 0.28
101.6	114.3	± 0.31
114.3	127.0	± 0.33

23.1.2 Where ratio of outside diameter to thickness is greater than 33 : 1, the tolerances shall be as agreed to between the purchaser and the manufacturer.

23.1.3 Thickness — The tolerance on thickness shall be ± 10 percent.

24. OTHER TESTS

24.1 In addition to the tensile test specified in 12.5 and the hydraulic test specified in 12.11, each selected pipe when tested in accordance with

either 12.6 or 12.7 or 12.9 shall satisfy requirements as laid down in Table 2 or 3 or 7 as appropriate.

TABLE 7 TEST REQUIREMENTS FOR CRUSHING TEST

PIPE DESIGNATION	MINIMUM REDUCTION OF ORIGINAL LENGTH AFTER CRUSHING
CDS 205	50 percent
CDS 245	25 percent

SECTION 4 ELECTRIC WELDED STEEL PIPES (ERW)

25. TENSILE PROPERTIES

25.1 The tensile properties of ERW steel pipes when tested in accordance with 12.5 shall conform to the requirements as laid down in Table 1.

26. DIMENSIONS AND DESIGN PROPERTIES

26.1 Dimensions of pipes shall be in accordance with Tables 4 and 8.

26.1.1 Design properties of the pipe are given in Appendix A.

TABLE 8 DIMENSIONS OF PIPES

All dimensions in millimetres.

OUTSIDE DIAMETER	THICKNESS
13.5	2.9
17.2	2.9, 3.2, 3.6
21.3	3.2, 4.0, 4.5
26.9	3.2, 3.6, 4.0, 5.4
33.7	4.0, 4.5, 5.0, 6.3, 7.1
42.4	4.0, 5.4, 5.9, 8.0, 8.7
48.3	4.0, 4.5, 5.9
60.3	4.5, 4.8

27. TOLERANCES

27.1 Pipes shall conform to the following tolerances:

- a) Outside diameter ± 1 percent
- b) Thickness (excluding weld) ± 8 percent

27.2 Height of the internal weld bead shall not exceed 0.25 mm.

28. OTHER TESTS

28.1 In addition to the tensile test specified in 12.5 and the hydraulic test specified in 12.11 each selected pipe when tested in accordance with either 12.8 or 12.10, shall satisfy the requirement as laid down in 12.8.1 or Table 9 as appropriate.

TABLE 9 TEST REQUIREMENTS FOR DRIFT EXPANDING TEST

PIPE DESIGNATION	INCREASE ON INTERNAL DIAMETER, PERCENT
ERW 205	12.5 percent
ERW 245	10 percent

APPENDIX A

(Clauses 18.2, 22.2 and 26.1.1)

DESIGN PROPERTIES

A-1. For the purposes of the standard the working pressure shall mean the normal gauge pressure that is anticipated for the pipes and joints when in operation. The design pressure shall include a suitable margin over the working pressure to allow for possible fluctuation of pressure during operation. The margin shall be individually determined for each application and it shall be based on the anticipated working conditions including pressure initiating system, pipe configuration and expected maximum surge pressure values. In any case, the design pressure shall be not less than the relief valve setting pressure or the safety valve setting pressure, should such a device or devices be fitted.

A-2. The design basis for calculating the thickness of the pipes shall be:

$$t_r = \frac{10.2 PD}{200f + P} + x$$

where

t_r = minimum pipe thickness in mm,

P = design pressure in N/mm²,

D = outside diameter of pipe in mm,

$f = \frac{\text{minimum tensile strength in N/mm}^2}{9.81 \times \text{factor of safety (see A-4)}}$, and

x = allowance for screwing or bending as appropriate (see A-5 and A-6).

A-3. The value t_f is the calculated minimum pipe thickness and allowance shall be made for the negative manufacturing tolerance for appropriate type of pipe as specified under different sections.

A-4. Factor of safety shall depend on the hydraulic medium to be used; it shall be taken as 4 for oil or other non-corrosive fluid, and 4.5 for water.

A-5. For screwed pipes, the allowance (x) shall be equal to half thread depth where this is greater than the bending allowance (see A-6).

A-6. The allowance (x) for thinning due to bending shall be 12.5 percent. This allowance applies to pipes bent to a radius not less than about 3D. The bending operation shall not produce a difference between the maximum and minimum diameters greater than 5 percent of the outside diameter of the pipe.

A-7. The thicknesses shown in Table 4 have been calculated on the basis of the appropriate design pressure ratings with allowance for screwing or bending and negative manufacturing tolerance, and have been rounded up to the nearest standard manufacturing thickness. In Table 4, the thickness shown for some of the smaller sizes is the minimum thickness suitable for parallel screwing and for vibration and shock respectively.

A-7.1 The actual pipe bores, which vary with thickness, are obtained from the outside diameter minus twice the specified thickness.

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221451

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2282808

First Floor, Plot Nos 657-660, Market Yard, Gultkdi, PUNE 411037

4288659

"Sahajanand House" 3rd Floor, Bhaktinagar Circle, 80 Feet Road,

2378251

RAJKOT 360002

T.C. No. 14/1421, University P.O. Palayam, THIRUVANANTHAPURAM 695034

2322104

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2712833

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